



May 15, 2021

VIA ECFS

Marlene H. Dortch
Secretary
Federal Communications Commission
45 L Street NE
Washington, DC 20554

RE: *Amendment of the Commission's Rules to Allow Next-Generation Wireless Charging Technology for Electric Vehicles Under Part 18, RM-11815; Targeted Changes to the Commission's Rules Regarding Human Exposure to Radiofrequency Electromagnetic Fields, ET Docket No. 19-226*

Dear Ms. Dortch:

I am writing as the chair of SAE International's Wireless Power Transfer and Alignment Task Force, SAE J2954 on behalf of and at the request of the task force, which consists of more than 150 international experts representing automakers, suppliers, users, national laboratories, and government agencies. The SAE J2954 task force urges the Commission to act swiftly in the matters concerning Wireless Power Transfer for Electric Vehicles operating in the frequency band of 79 kHz to 90 kHz.

One goal towards mass production for electric vehicles is to make a significant reduction in the emissions, especially greenhouse gases. These industrial efforts are an important step towards fighting global climate change, improving our living conditions, and taking care of our community's health. The various solutions developed to support the challenge of carbon reduction also offer novel economic opportunities in the areas of science, technology, engineering, and mathematics in the United States of America.

The Transportation sector contributes to over 28% of the global greenhouse gas emissions, the largest share of any category. Therefore, a critical part of the solution to reduce these emissions resides in the replacing vehicles with electric powertrains instead of internal combustion. Electric vehicles (EVs) operate at high efficiency and create zero local emissions, and as a result, offer a significant means for reducing emissions from transportation. To date there have been some limited successes in electric vehicle adoption, however they only make up less than 1% of the cars on the road today. One issue in adoption is the accessibility and acceptance of charging infrastructure. A key technology that has been developed that can help drive EV adoption is the availability of wireless charging systems for electric vehicles. This technology offers the customer a seamless charging experience as they simply park at an enabled parking location and the vehicle is automatically charged without the need for driver intervention. For wireless charging systems, there is no requirement for the driver to remember to plug in or mess with any heavy or dirty cables.

Wireless Power Transfer for Electric Vehicles (WPT-EV) is the safe and efficient transfer of electrical power from the AC supply network to the electric vehicle by contactless means. WPT-EV is an automated and touchless charging method that transfers power across an airgap from a Ground Assembly (GA) to a Vehicle Assembly (VA) and then rectifies that power into DC voltage to charge the vehicle batteries. WPT-EV systems operate at similar efficiencies to plug-in charging with tests showing actual grid-to-battery efficiency that often exceeds 90%.

The wireless power transfer portion of a system includes only local energy transfer with no communication occurring at the resonant power transfer frequency. The frequency range of operation, 79 kHz to 90 kHz, was carefully selected by several Standard Development Organizations (SDOs) including SAE J2954, ISO 19363, IEC 61980, and the Chinese GB/T 38775.4 standards for its low probability for electromagnetic interference to other radio services (EMC) as well as its ease of verifying dosimetry levels to be compared against international requirements for exposure to non-ionizing radiation to humans (EMF) and Cardiac Implantable Electronic Devices (CIED). Communication for WPT-EV system operation occurs over wireless LAN and is undisturbed by the power transfer process.

In support of this important technology, the SAE J2954 Wireless Power Transfer and Alignment Task Force requests that the Commission act swiftly and urgently to amend its Part 18 rules under Title 47 of the Code of Federal Regulations. In particular, the SAE J2954 task force requests that the Commission increase its radiated emission limits under Part 18 for WPT-EV systems operating in the frequency range of 79 kHz to 90 kHz to 82.8 dB μ A/m when utilizing a measurement distance of 10 meters. To determine compliance with the new limits, Commission guidance should employ the testing methodologies specified in the ANSI C63.30 Standard, “Methods of Measurement of Radio-frequency Emissions from Wireless Power Transfer Equipment”. These limits and methods are in harmony with the published SAE J2954 Standard¹.

To underscore the need for urgent action and provide supporting rationale on this topic, the SAE J2954 Wireless Power Transfer and Alignment Task Force provides the important feedback attached for the Commission’s immediate consideration.

¹ https://www.sae.org/standards/content/j2954_202010/

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LETTER OF SUPPORT FROM THE SAE J2954 TASK FORCE

The SAE J2954 Wireless Power Transfer and Alignment Task Force consists of more than 150 international experts representing automakers, suppliers, users, national laboratories, and government agencies. The SAE J2954 task force has been an active committee of SAE International, previously known as the Society of Automotive Engineers, for more than a decade. During this time, SAE J2954 has actively studied wireless power transfer for electric vehicles (WPT-EV) including the topics of electromagnetic compatibility and interference (EMC and EMI), electromagnetic field (EMF) safety for humans and cardiac implantable electronic devices (CIEDs), communications, automated alignment, interoperability, as well as many other topics.

The SAE J2954 task force established an SAE J2954 Cooperative Research Program (CRP) to perform practical testing with WPT-EV and provided public summary reports^{2,3}. As part of these efforts, the SAE J2954 taskforce has involved members of the USDOT, USDOE, FCC, FDA, ANSI, AAMI, and others to participate and provide feedback. Early in its work, SAE J2954 entered a memorandum of understanding with UL to produce UL 2750 safety standards for WPT-EV infrastructure equipment. Additionally, SAE J2954 created a memorandum of understanding with ISO 19363 to harmonize WPT-EV standards globally between ISO 19363, IEC 61980, and SAE J2954. Additional liaison also occurred with the Chinese GB/T 38775 Committee to affect some harmonization in China also.

As a result of this substantial effort, the SAE J2954 task force created a technical information report (TIR) in the year 2016 followed by two recommended practices (RPs) in 2017 and 2019. Finally, after more than a decade of effort, SAE J2954 released the first Standard in October of 2020.

DISCUSSION

The SAE J2954 Wireless Power Transfer and Alignment Task Force acknowledges the petition of Toyota Motor North America, Inc. ("Toyota"), Ford Motor Company ("Ford"), BMW of North America, LLC ("BMW") and Nissan North America, Inc. ("Nissan," together with Toyota, Ford and BMW, the "Petitioners") to amend the Commission's Part 18 rules under Title 47 of the code of federal regulations. It also acknowledges the Commission's pending notice of proposed rulemaking to facilitate WPT deployments under Part 18, Part 15, or a new rule part⁴. SAE J2954 asks the Commission to act swiftly and urgently in adopting higher Part 18 limits for WPT-EV systems operating in the frequency range of 79 kHz to 90 kHz, as sought in the automakers'

² <https://www.sae.org/publications/technical-papers/content/07-11-02-0009/>

³ <https://www.sae.org/publications/technical-papers/content/2019-01-0868/>

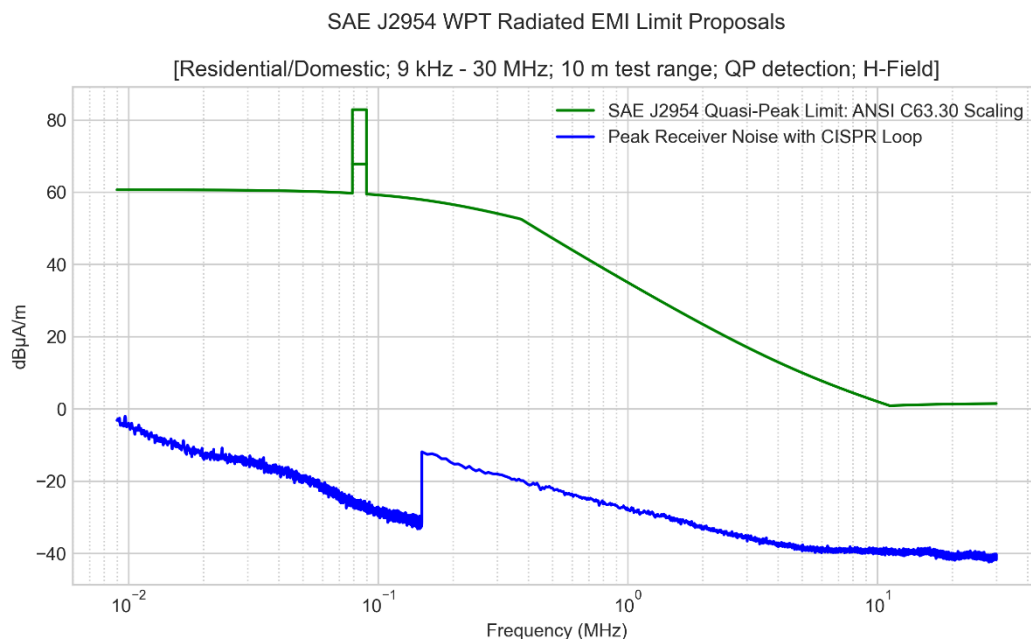
⁴ *Targeted Changes to the Commission's Rules Regarding Human Exposure to Radiofrequency Electromagnetic Fields*, ET Docket No. 19-226, Resolution of Notice of Inquiry, Second Report and Order, Notice of Proposed Rulemaking, and Memorandum and Order, 34 FCC Rcd. 11687 ¶¶ 138-142, 145 & n.390 (2019).

petition. To assist the Commission on this topic, the SAE J2954 task force provides important points of discussion for the Commission’s consideration.

A. WPT-EV Operation and Limits for 79 kHz to 90 kHz

The SAE J2954 task force created a sub-team, with world-recognized electromagnetic experts, to initiate a multi-year effort in determining the best frequency band for WPT-EV operation. SAE J2954 was the first to standardize a nominal frequency of 85 kHz as the fundamental frequency in the year 2016. Initially, the recommendation included operating the WPT-EV system within 81.38 kHz to 90 kHz and was later extended to include 79 kHz to 90 kHz. SAE J2954 has worked with many countries and international organizations such as CISPR (CIS/B) and ITU-R to support this frequency of operation. Now, the 79 kHz to 90 kHz frequency band is a globally harmonized recommendation for WPT-EV operation in ITU-R Recommendation SM.2110⁵.

Based on many years of review and testing with actual systems, the SAE J2954 Standard specifically states, “The recommended limit for the frequency range of 79.00 to 90.00 kHz for WPT is 82.8 dBuA/m. The recommended limits are for a 10 m antenna distance.” The following plot showing these limits along with the relevant Part 18 limit scaled to a distance of 10 m (using the method specified in ANSI C63.30 created by the FCC’s Joseph McNulty⁶) is shown in the Standard and included for reference.



A system compliant to SAE J2954 standard (or any of the related global standards) operates at a fixed frequency and produces a single-carrier signal without modulation. The frequency band is provided so that frequency selection, prior to power transfer, can be performed in a way that

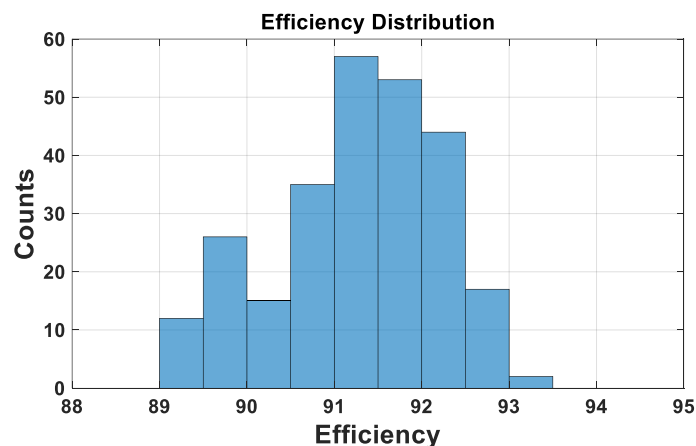
⁵ https://www.itu.int/dms_pubrec/itu-r/rec/sm/R-REC-SM.2110-1-201910-I!!PDF-E.pdf

⁶ <https://www.fcc.gov/document/radiated-magnetic-field-emission-measurements-below-30-mhz>

optimizes efficiency. The SAE J2954 Standard indicates this requirement with the following statement.

“The nominal power transfer frequency of the SAE J2954 frequency range is 85 kHz. In order to optimize performance, if it is necessary to use a different power transfer frequency, determination of that frequency shall be done at the start of a charge session and shall be accomplished at no more than 25% of the full power of the charging system (the lower of the GA input power rating and the VA output power rating). The power transfer frequency shall remain constant (within a ± 50 Hz range) for the duration of the charge session.”

Additionally, AC grid to DC battery efficiencies have been measured by the SAE J2954 CRP utilizing Idaho National Laboratories (INL) as a third-party testing facility. The plot below is a histogram of measured efficiency with all valid offsets between the GA coil and VA coil resulting in a range of efficiencies from 88% to 93%.



Specifically, the fundamental frequency limits in the 79 kHz to 90 kHz band specified in the SAE J2954 standard were based on significant research efforts of the SAE J2954 task force combined with extensive testing courtesy of an industry funded SAE J2954 cooperative research program (CRP). The SAE J2954 CRP and the SAE J2954 task force have published or contributed several technical papers on the topic of the WPT-EV operation. In one of the technical papers entitled *Validation of Wireless Power Transfer up to 11kW Based on SAE J2954 Bench and Vehicle Testing*⁷, the SAE J2954 CRP tested a variety of different WPT-EV ground assembly (GA) and vehicle assembly (VA) subsystems from different suppliers together for interoperability. The systems provided were based on technical criteria specified by SAE J2954 including high standards of end-to-end efficiency, meeting the ICNIRP 2010 reference exposure level, as well as height and misalignment criteria. As part of this testing, a substantial number of EMC measurements of the fundamental were also made at the fundamental frequency. In all cases, the power level was WPT3 as defined by the SAE J2954 Standard which implies up to ~11 kW of input power at the AC mains input and a typical end-to-end efficiency of ~91%. The detailed results are provided in the publicly available technical paper and show a maximum fundamental frequency quasi-peak emission of about 63 dB μ A/m at a measurement distance of

⁷ <https://www.sae.org/publications/technical-papers/content/2019-01-0868/>

10 m when a circular topology coil is used for both the GA and VA at this power level. When using an alternate “DD” coil topology for both the GA and VA, the maximum quasi-peak value for the same power and measurement conditions resulted in a field level of about 79 dB μ A/m. Under worst-case conditions of interoperability between a circular GA coil and a DD VA coil, the quasi-peak value reached approximately 81 dB μ A/m when operating at WPT3 power levels and measuring at a 10 m distance. The SAE J2954 Standard concludes that to enable efficient operation up to WPT3 power levels, “The recommended limit for the frequency range of 79.00 to 90.00 kHz is 82.8 dB μ A/m (limits shall be reduced by 15 dB to 67.8 dB μ A/m for EV WPT installations within a distance of 10 m from known sensitive equipment in public spaces)...”. SAE J2954 recognizes that some designs using only a circular coil topology might be much lower than the stated limit of 82.8 dB μ A/m for WPT3 operation; however, it is important to also recognize that the current SAE J2954 Standard is a first edition with limited power classes. In fact, the standard presently states, “Additional WPT power classes, with maximum input volt-amps of 22 kVA (WPT4) and 60 kVA (WPT5) are under consideration for the next version of this standard.”

B. Interference from WPT-EV Harmonic and Spurious Emissions

Under filings for RM-11815, SAE J2954 notes that all commenters providing comments on WPT-EV indicated support for increasing limits in the range of 79 kHz to 90 kHz with the only exception being ARRL, whose comments were received after the 30-day commenting period. In the opposing comments, ARRL expressed specific concern about “...the harmonic interference and other out-of-band emissions from WPT-EV systems...” as it relates to amateur radio and stated that such a rule-making would be “premature”.⁸ ARRL referred back to these same comments when responding to the pending NPRM on WPT.⁹

The SAE J2954 task force includes experts that are licensed amateur radio operators and recognizes the concerns of ARRL as it pertains to potential harmonic and spurious emissions from WPT-EV systems. Of course, all WPT-EV systems would be expected to meet the existing radiated emission limits specified in Part 18 before being deployed. In an effort to help mitigate concerns of ARRL, the SAE J2954 CRP performed extensive radiated emission testing and EMF measurements over a 3-week period utilizing TDK RF Solutions in Cedar Park, Texas as an independent third-party lab. Staff from ARRL and the president of IARU region 1 were invited to participate in that testing, and they proposed additional tests that were performed. During that effort, an amateur radio station was set up at multiple distances from the Open Area Test Site (OATS) with an on-vehicle WPT-EV system operating in worst-case conditions (i.e., maximum alignment offset, worst-case angle of rotation, etc.). The results of that impact study,¹⁰ showing no harmful interference, were contributed by the USA as a US consensus document to ITU-R for inclusion in a future revision of ITU-R Report SM.2451¹¹ on WPT-EV. Since that initial ITU-R contribution, an additional consensus document¹² regarding the amateur radio impact study has

⁸ Comments of ARRL at 3, RM-11815 (filed Oct. 29, 2018).

⁹ Reply Comments of ARRL at 6-7 & nn.18-20, ET 19-226 (filed July 20, 2020).

¹⁰ <https://uspreps.ntia.gov/file/14/download?token=DCTpxmYw>

¹¹ https://www.itu.int/dms_pub/itu-r/opb/rep/R-REP-SM.2451-2019-PDF-E.pdf

¹² https://uspreps.ntia.gov/file/445/download?token=F6_gHWi5

been provided for national committee review and will soon be contributed by the USA to ITU-R Working Party 1A to further enhance ITU-R Report SM.2451.

In addition to contributions to ITU-R, the SAE J2954 task force has contributed to the European CEPT SE 24 group on the topic of WPT-EV spurious and harmonic emissions. It was noted by CEPT SE 24 that the premature ECC Report 289¹³ did not have sufficient input from industry and did not include measurements with actual systems. Accordingly, CEPT SE 24 has solicited new input from the WPT-EV industry and has started a new working document. SAE J2954 contributed its amateur radio impact study¹⁴ and answered questions in response documents to IARU¹⁵ and EBU¹⁶. Furthermore, a completely independent study¹⁷ performed on a different WPT-EV system was carried out in Switzerland by Swiss amateur radio operator experts (USKA), the Swiss regulatory body (BAKOM), and Brusa. This impact study also shows no interference by a production WPT-EV system to amateur radio whatsoever.

C. EMF Human and CIED Safety Considerations in SAE J2954 Standard

As previously noted, the SAE J2954 CRP has also performed extensive EMF testing for human safety and for potential impact on cardiac implantable electronic devices (CIEDs). As part of this testing, SAE J2954 members provided several WPT-EV systems that were sent to the FDA to perform analysis with actual pacemaker systems. The SAE J2954 Standard has incorporated detailed EMF limits and test methods based on well-known guidelines, such as ICNIRP 2010 and ISO 14117. The EMF limits and methods in the SAE J2954 Standard are very conservative resulting in stricter requirements than even the proposed FCC amendments¹⁸ to Title 47, Part 1, § 1.1310 from 3 kHz to 10 MHz.

Relatedly, if the Commission adopts the proposed amendments to Section 1.310, it should ensure that standard testing practices are available to demonstrate compliance. The newly proposed FCC requirements amount to restriction on the internal electric field (of the body) only and do not give consideration for reference level type measurements such as maximum permissible exposure (MPE) levels otherwise provided by the FCC above 300 kHz. In order to promote standard practices for test methods indicated in the SAE J2954 Standard, the SAE J2954 task force requests that the FCC specifically indicate that magnetic field measurements performed in accordance with SAE J2954 EMF test methods resulting in magnetic field values of 27 μ T or less, from 79 kHz to 90 kHz, are sufficient evidence to meet any new internal electric field limits for General Population/Uncontrolled Exposure in § 1.1310 (f) that the FCC may adopt. This can be done by providing equivalent MPE values from 3 kHz to 300 kHz that correspond to reference levels indicated in ICNIRP 2010 Guidelines¹⁹ or exposure reference levels indicated in IEEE C95.1-2019²⁰.

¹³ <https://docdb.cept.org/download/2fed7e3c-7543/ECC%20Report%20289.pdf>

¹⁴ https://www.cept.org/Documents/se-24/59514/wi6018-4_impact-study_wpt-ev

¹⁵ https://www.cept.org/Documents/se-24/59845/wi6020-2_reply-commentary-on-impact-study

¹⁶ https://www.cept.org/Documents/se-24/61074/wi6022-3_reply-comments-to-ebu

¹⁷ https://www.cept.org/Documents/se-24/62748/wi6026-01_rev1_interference_between_ev_inductive_charging-and-radio-amateur-service

¹⁸ <https://ecfsapi.fcc.gov/file/1204525609818/FCC-19-126A1.pdf>

¹⁹ <https://www.icnirp.org/cms/upload/publications/ICNIRPLFgdl.pdf>

²⁰ https://standards.ieee.org/standard/C95_1-2019.html

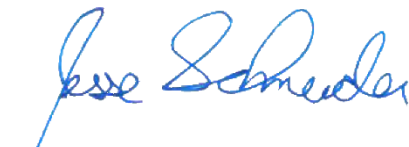
D. WPT Certification Process

The SAE J2954 task force has had a liaison relationship with the ASC C63 Subcommittee 4 that produced the ANSI C63.30 Standard. The SAE J2954 task force believes that the current pre-authorization requirements in KDB 680106 are outdated and unnecessary. The SAE J2954 task force agrees with the ASC C63 Subcommittee 4 comments²¹ in the FCC's NPRM 19-226 that propose that the "FCC investigate 'Type' accreditation for vehicular WPT transmitting units, similar to the process currently used for modular devices under Part 15C." The SAE J2954 Standard already conceives of this approach and provides detailed methodologies for such interoperability testing – inclusive of EMC and EMF restrictions.

CONCLUSION

The SAE J2954 task force would like to thank the Commission for its work related to wireless power transfer for electric vehicles. The task force urges the Commission to adopt a radiated emission limit of 82.8 dB μ A/m under Part 18 from 79 kHz to 90 kHz when utilizing a measurement distance of 10 meters. The task force also urges the Commission to support the testing methodologies specified in the ANSI C63.30 standard through the issuance of OET guidance. Should the Commission act on its proposal to adopt new internal electric field limits between 3 kHz and 10 MHz, the task force further requests that the Commission update KDB 680106 to indicate that magnetic field reference level measurements at or below 27 μ T, in accordance with ICNIRP 2010, are sufficient to show compliance in the frequency range of 79 kHz to 90 kHz. Finally, the SAE J2954 task force requests that the FCC allows "Type" accreditation for WPT-EV Ground Assembly systems.

Sincerely,



Jesse Schneider
CEO/CTO ZEV-Station, LLC
Chair, SAE Wireless Power Transfer & Alignment

On Behalf of
The SAE J2954 Task Force

²¹ <https://www.fcc.gov/ecfs/filing/1060338411833>